Feed Adaptation

Core Drill

BACKGROUND OF THE INVENTION

The invention relates to a feed – controlled core drill, in particular a pedestal–guided diamond core drill for reinforced concrete, and an associated control method.

When core drilling rock, ultra hard cutting edges or diamonds of the drill bit penetrated slightly into the substrate and carry it away. The high torque and feed pressures required for core drilling rock are usually applied against a machine pedestal, which is solidly connected with the substrate. If the control of the feed is effected manually by the operator using a lever wheel, a substrate – specific optimum penetration depth of the blades is not possible, by which early wear of the cutting edges results along with reduced drilling performance.

According to DE 19707899, an adaptive feed control for a pedestal – guided diamond core drilling machine is disclosed, which controls the feed using a PID controller depending on the current consumption of the electrical motor or a torque relative thereto. As a consequence of this type of power – based control, there is only one maximum torque available at a constant speed pre-defined by the gear reduction ratio. Changes in the substrate such as encountering reinforcement leads to non-optimum torque / speed – pairings.

In addition, as disclosed in US 4,618,805, a drill machine has an electrical motor with a motor control, which can be pre-set to the motor characteristic curve of maximum power for different working points independent of each other and can be switched automatically between the working points.

SUMMARY OF THE INVENTION

The object of the invention is to provide an feed – controlled core drilling machine and an associated control process, which reacts to changes in the substrate without interrupting the drilling operation by optimum torque / speed – pairs.

This object is achieved, in accordance with the invention, by a core drilling machine having an electrical motor for providing rotational drive of a core drill bit with cutting edges oriented axially to a work piece, a feeding means for generating the feed of the core drill bit against the work piece and a controller for controlling relative to a first control parameter detected by a sensor for one-to-one the electrical consumption or torque, whereby a force sensor for detection of the contact pressing force of the core drill bit is connected with the controller as a second control parameter.

With the additional detection of the contact pressing force, advantageously detected by the current consumption of the feed motor, as the second control parameter, a substrate – specific frictional coefficient is determined with the one-to-one first control parameter or the power consumption or torque, and this coefficient is used as the control parameter for controlling the feed of the core drill bit, which directly describes the microphysical abrasion of the cutting edges.

It can be shown that the substrate – specific frictional coefficient can be generally calculated from a measured power consumption or the torque produced and a normal force.

Advantageously, the force sensor is configured as a piezo force sensor and arranged in an axial bearing zone of the drive spindle, whereby the normal force is directly measurable in the core drilling machine.

Alternatively, the force sensor is configured as a force sensor (for example a current sensor or torque sensor) of the feeding means, i.e. of the feed motor, whereby the normal force is directly measurable in the feeding means.

Advantageously, the controller is configured as a microcontroller, whereby the frictional coefficient utilized as the control parameter can be calculated numerically and accordingly free of drift.

Advantageously, the controller is connected to an entry means (for example, a keyboard or a selection switch) for the radius of the drill bit; further advantageously, with a transponder, which queries an identification means on the drill bit, whereby the control is effected specifically for the actual drill bit diameter.

Advantageously, in the controller different torques or speeds are associated with at least two different frictional coefficients, whereby the feed of the core drill bit is controlled as a factor of the detected substrate and matched to the respective substrate.

Advantageously, the electrical motor is controllable connected to a motor control connected to the controller in the feeding means, which can electronically switch the at least two different working points of the electrical motor, which lie on the motor characteristic curve of maximum power, whereby the electrical motor with the motor control provides an electronic gearing, which is controllable by the controller. Frequency – inverting fed asynchronous machines with large field weakening range are particularly suited as electrical motors.

Advantageously, different torques or speeds in the controller are associated with at least two different frictional coefficients, whereby the working point of the core drill bit is controlled as a factor of the detected substrate and matched to the respective substrate.

Advantageously, the controller in the feeding means is connected by a bi-directional optical interface with the motor control for transmission of the sensor measurement values and the optimum torque / speed – pairings of the controller, whereby a galvanic separation of the feeding means mechanically connected to the drill pedestal from the usually water – cooled electrical motor is realized.

In the associated process for controlling a core drilling machine with an electrical motor for rotational driving of a core drill bit, in a first step, a first control parameter dependent on the power of the electrical motor is detected using a sensor; this control parameter is evaluated by a controller in a second step and in a third step a feeding means for the core drill bit is controlled by the controller. In the first step, a second control parameter that is dependent on the contact pressing force is detected using a force sensor, in a second step a control parameter one-to-one with the frictional coefficient is determined by the controller from the first and the second control parameters and this data is used for controlling the feeding means, in a third step.

Advantageously, in the third step, motor control of the electrical motor using the control parameter is regulated relative to at least two different working points, which lie on the maximum power of the motor characteristic curve.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more completely described with reference to the drawings, wherein:

Fig 1 shows a side view of a core drilling machine with a core drill bit according to the invention; and

Fig. 2 shows a variant of the embodiment shown in Fig. 1.

DETAILED DESCRIPTION OF THE INVENTION

According to Fig. 1, a core drilling machine 1 has an electrical motor 2 for rotationally driving a core drill bit 3 with ultrahard cutting edges 5 that are oriented axially to a work piece 4 and a feeding means 6 having a controller 7 for controlling the feed of the core drill bit 3 against the work piece 4. The control is effected depending on a control parameter one-to-one with the substrate – specific frictional coefficient μ, which is determined by the controller 7 from an electrical power P detected using a sensor 8 in the current path of the electrical motor 2 and from a contact pressing force F_N of the core drill bit detected using a force sensor 9. $\mu = P / (2\pi \; n \; r \; F_n) = M / (r \; F_N)$, with μ: frictional coefficient: P: power consumption; M: torque; F_N: normal force; r: radius of the drill bit. The force sensor 9 is configured as a piezo force sensor and arranged in a thrust bearing zone 10 of a drive spindle 11 of the core drilling machine 1. In the controller 7 configured as a microcontroller, respectively different torques M_I or speeds n_I are tabularly assigned to a plurality of different frictional coefficients μ_I. The electrical motor 2 configured as a frequency – inverter supplied asynchronous machine with large field weakening range is connected to a motor controller that is controllably connected to the controller 7 in the feeding means 6, which can electronically switch a plurality of different working points A_I of the

electrical motor 2, which lie on the motor characteristic curve of maximum power P_{max}. In the controller, a plurality of different frictional coefficients μ_I are tabularly assigned to respectively different torque / speed – pairings [M_i / n_i]. According to Fig. 2, in a variant embodiment, the force sensor 9' is configured as the force sensor of the feeding means 6 and arranged in the current path of an feed motor 13. The controller 7 is connected to an input means 14 in the form of a transponder, which queries an identification means 15 arranged on the core drill bit 3, using the radius r of the core drill bit. The controller 7 is connected by a bi-directional optical interface 16 with a sensor 8' measuring the torque M of the drive spindle 11 and to the motor controller 12 for transmission of the optimum torque / speed – pairings [M_i / n_I].